GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

WEATHER SUMMARY FOR FEBRUARY, 1889.

Simla, the 13th March 1889.

February is usually the last cold-weather month of the year in Northern India, as hot-weather conditions generally set in at the end of this month or the beginning of the month of March and rapidly intensify. It is occasionally a very unsettled stormy month in Upper India and the adjacent hill districts, more especially if the preceding month has been finer than usual. The majority of the most severe cold-weather storms of recent years have occurred during the last week of January and first ten days of February. The storms of the month usually belong to the class known as cold-weather storms, the chief features of which have been described in the two previous monthly reports. These are generally shallow depressions but are almost as persistent as the storms of the rains proper. They usually move quickly and in the great majority of cases advance in an easterly course and hence in the opposite direction to the storms of the rains. Each storm gives moderate to heavy snow to the hill districts and light to moderate rain, chiefly in the plain districts to the north of the area of lowest barometer. One of the more remarkable features of these storms is the temperature relations and changes which accompany them. Temperature is generally considerably above the normal before the formation of each storm. A rapid increase of temperature generally occurs immediately in front of the advancing storm, and an even more rapid decrease of temperature takes place in the rear of the storm, where fine clear weather with westerly winds usually prevails. Hence a wave of high temperature appears to advance across Northern India in front of each of these storms and a similar wave of low temperature follows them.

Another interesting feature of the temperature conditions of the month is that the changes and variations of temperature in Southern India are usually inverse to those in Northern India, that is, when temperature is excessive and increasing in Northern India, it is below the normal and decreasing in Southern India, and *vice versâ*.

The past month has been unusually stormy and rainy in Northern and Central India, and the temperature relations indicated in the preceding remarks have been exhibited to a marked extent during the month.

BAROMETRIC DEPRESSIONS AND STORMS OF THE MONTH.

First storm of January 27th to February 3rd.—This was fully described in the previous month's report. It was a double storm consisting of a shallow depression which drifted from Beluchistan across the head of the Peninsula into Burma and of a deep depression which formed in the North Punjab and advanced for some distance eastwards along the Himalayas and filled up on the 31st. The shallow depression was passing through East Bengal into Upper Burma on the 1st, and local showers were received in Assam and Bengal on that day. It gave low barometer and cloudy skies but no rain to Burma on the 2nd.

A very rapid rise of the barometer in Northern India on the 1st and 2nd established anticyclonic conditions with fine cool weather and westerly winds. The fall of temperature following the storm continued until the 3rd, when the variations of the mean temperature of the day from the normal were as follows:—

Sind and Rajputana	6° below.
North-Western Provinces	5° ,,
Punjab	4° ,,
Guzerat and Central India	
Central Provinces ..	2° ,,
Bengal	
Bombay	1½° above.
Madras	1½° ,,

This storm gave a heavy fall of snow in the hill districts and general rain to the Punjab, North-Western Provinces, Rajputana, Central India, Behar, Chutia Nagpur and Bengal.

Depression of 5th to 8th February.—This was a very shallow depression and of little importance. It appeared in Sind on the morning of the 5th. Temperature increased very rapidly in Sind, Rajputana and Guzerat on the 5th, in the Central Provinces on the 6th, and in the North-Western

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Provinces and Bengal on the 7th. The average variations of the mean temperature from the normal on these days and on the 8th were as follows :—

	Average Temperature Variation.				
	4th.	5th.	6th.	7th.	8th.
Punjab	—1½°	—1°	+3°	+3½°	+3°
Sind and Rajputana	Normal.	+5	+5½	+4	+4
North-Western Provinces	—5	—2½	+1	+4½	+8½
Central India	—2½	+2	+4	+8½	+1½
Central Provinces	—4½	—1	+4½	+7½	+7½
Bengal	—4½	—3	—2	+ ½	+2
Bombay	+1	+1½	+2	+3	+3½
Madras	+1½	+2	+1	+ ½	—1

The depression passed into Bengal on the 8th and gave some cloud and filled up on the 9th.

Little or no rain fell in the plains or hills during the advance of this depression and hence the temperature relations were different from those of the preceding storm, and no rapid fall of temperature occurred in the rear of the storm.

Depression of 10th to 13th February.—The barometer fell rapidly on the 9th in North-Western India and a shallow depression overlay Guzerat and South-West Rajputana on the morning of the 10th. Thunderstorms giving light showers occurred during the day in Central India, Rajputana and the South-East Punjab.

The depression was transferred to Chutia Nagpur and the adjacent districts on the morning of the 11th, and numerous thunderstorms and light showers had fallen during the previous twenty-four hours in the North-Western Provinces and Central India. Temperature was now decreasing rapidly in North-Western and Central India and increasing briskly in Eastern India.

The depression passed into Central Bengal on the morning of the 12th. Thunderstorms giving moderate rain occurred in Behar and Bengal during the previous twenty-four hours.

Temperature increased rapidly on the 12th in Burma, East Bengal and Assam and was now falling steadily in North-West and Central India. The following gives the temperature variations of the 9th, 10th, 11th, and 12th :—

	Average Temperature Variation.			
	9th.	10th.	11th.	12th.
Punjab	+4½°	+3½°	+3½°	+4°
Sind and Rajputana	+6°	+1 °	+1°	+3½°
North-Western Provinces ..	+4½°	*Nil*	+1°	+2°
Central India	+10½°	+4°	*Nil*	+1½°
Central Provinces	+9½°	+6°	*Nil*	—10°
Bengal	+2½°	+4°	+4½°	—½°
Assam	+1½°	+4°	+7½°	+2°
Bombay	+3°	+1°	—½°	+ ½°
Madras	— ½°	+2°	+1½°	+½°
Burma	— ½°	+2°	+2°	+1½°

The depression passed into Burma on the 13th when it filled up.

Temperature increased rapidly in North-Western India on the 14th and 15th and decreased in North-Eastern India. A fall of the barometer in Beluchistan and Sind on the 15th preceded the advance of another depression from Beluchistan.

Depression of 16th to 19th February.—The depression shown by the Quetta observations on the 15th covered Guzerat and South-West Rajputana on the 16th. The temperature variations of the 15th immediately antecedent to the storm were as follows :—

Sind	5½° above.
Rajputana	10° ,,
Guzerat and Central India	8½° ,,
Central Provinces	7° ,,
North-Western Provinces	4½° ,,
Bengal	2° ,,
Madras	2° below.

The depression changed its character during the next twenty-four hours and, at 8 A. M. on the 17th, formed a long trough stretching from the Central Provinces to the South-East Punjab. Heavy rain fell on the 16th and 17th over the whole of this area, except the southern portion of the Central Provinces. Falls of one inch were recorded on the 17th at Satna and Nowgong and at the Hill Stations. The depression was transferred to Bengal on the 18th. Temperature had increased rapidly in North-East India and fallen very quickly in North-West and Central India. Temperature variations on the 16th, 17th, 18th, and 19th were as follows :—

	16th.	17th.	18th.	19th.
Punjab	+1°	+1°	+2½°	+3°
Sind and Rajputana	+1°	—3°	*Nil*	+3½°
North-Western Provinces	+3°	—4°	—1°	—1½°
Central India	+3°	—2°	—2°	—1°
Central Provinces	+4°	—2°	—3	—4½°
Bengal	+2½°	+3½°	+3°	—2½°
Bombay	+2°	—1°	—2°	—1½°
Madras	—2°	—1°	*Nil*	+½°
Burma	+3°	+3½°	+3½°	+4½°

Moderately heavy rain fell on the 17th in the North-Western Provinces, Chutia Nagpur, and Behar. The depression passed into Bengal on the 19th, but filled up and disappeared before the morning of the 20th. It gave some local thunderstorms on the 18th and 19th in Bengal.

Temperature again began to increase rapidly in North-West India and continued to decrease in North-East India, and on the 21st the temperature variations were as follows :—

Quetta	15½° above.
Sind and Rajputana	7½° "
Punjab	3½° "
Central India	2½° "
Central Provinces	½° below.
Bengal	3½° "
Assam	1° "
Burmah ..	

Depression of 22nd to the 25th February.—This was by far the most remarkable storm of the month, partly by reason of the unusual direction of its advance and partly by reason of the excessive burst of rainfall it gave to the whole of the Punjab. It formed in East Beluchistan and Sind on the 21st and 22nd, and advanced in a northerly instead of the usual easterly direction. The centre was between Mooltan and Jacobabad on the morning of the 23rd. Light showers fell on the 22nd in the hill districts, and skies were densely covered over the Punjab. On the morning of the 24th, the centre was to the west of Dera Ismail Khan, and the depression had increased to a third of an inch. Very heavy rain had fallen in the Punjab during the previous twenty-four hours. Murree received 5 inches, Rawalpindi 3¾ inches, Lahore 2½ inches and Ludhiana and Simla 2 inches. The depression filled up with unusual rapidity during the day. The rise of the barometer was larger and more rapid than has been observed for many years in the Punjab, and exceeded half an inch at Peshawar. Showers were received during the previous day in the Punjab and north-western districts of the North-Western Provinces.

Strongly marked anticyclonic conditions were re-established in Upper India on the 25th, when pressure was two-tenths of an inch above the normal in the North Punjab, and this continued during the remainder of the month.

Hence, of the four depressions or storms of the month, three advanced across Northern India in the usual direction, whilst the fourth marched northwards parallel to, or more probably over, the Suliman Mountains and developed until it reached the much higher ground to the north of the Punjab when it broke up very rapidly. Its history hence confirms the supposition that these cold-weather storms are generated and maintained at a very considerable elevation, and are not primarily phenomena of the lower atmosphere.

Pressure.—The mean pressure of the month for the whole of India was ·024″ in excess of the normal. The excess was, as in the month of January, greater at the hill than the plain stations. Pressure was relatively to the general state in defect generally in Northern India. There were two areas in which the local deficiency exceeded ·02″, *viz.*, Sind and Rajputana, and Burma. The following gives data :—

	Relative deficiency.
Jacobabad	—·032″
Kurrachee	—·024″
Ajmere	—·022″
Akyab	—·022″
Diamond Island	—·023″

Pressure was relatively in excess over the greater part of the Peninsula, but the abnormal variations exceeded ·02″ only at Ratnagiri (·027″) and Bellary (·022″).

Temperature.—The chief feature of the temperature of the month, *viz.*, the rapid fluctuations which accompanied the passages of an unusually large number of storms across Northern India, has been already fully shown in the preceding remarks. The cloudy weather which accompanied these storms increased the night temperature and diminished the day temperature. This effect is shown very clearly in the average temperature variations of the month in Northern India given below :—

	Variation of maximum temperature from normal.	Variation of minimum from the normal.	Variation of mean temperature from normal.
Burma	+0·8	+1·4	+1·1
Bengal and Assam	—0.4	+1·3	+0·5
Behar	—2·0	+3·0	+0·5
North-Western Provinces	—2·5	+3·0	+0·2
Punjab	—1·0	+3·5	+1·2
Rajputana	—1·2	+3·2	+1·0
Bombay	+1·0	+0·3	+0·7
Madras	+0·7	—0·4	+0·2
Berar and Central Provinces	+1·2	+1·9	+1·6
Central India—Guzerat	+1·0	+2·4	+1·7

Rainfall.—The most remarkable feature of the weather of the month is the rainfall. The whole of the Punjab, North-Western Provinces, Chutia Nagpur, Rajputana, and Central India received from two to ten times their normal amount. In Bengal and Assam there was a moderate excess. In the Central Provinces, the Deccan, and Southern India the rainfall of the month is always very small in amount, but was even smaller than usual during the first month.

The conditions of its occurrence were as abnormal as its amount. Excessive rainfall in February [such as that of the past month] usually accompanies excessive rain throughout the whole of the cold-weather months, as was the case in the cold weather of 1877. The excessive rain of the past month on the contrary followed a period of drier weather than usual in the months of December and January.

The following table gives the actual and average rainfall at several typical stations in Northern India for two periods, *viz.*, one from the 15th of December 1888 to the 27th of January 1889, and the second extending from 27th January to the end of February :—

Provinces.	Stations.	Rain-fall from 15th December to 27th January.			Rain-fall from 28th January to 28th February 1888.		
		Actual.	Average.	Variation.	Actual.	Average	Variation.
Punjab ...	Rawalpindi ...	0·53	2·85	—2·32	11·81	2·06	+9·75
	Sialkot ...	0·26	1·99	—1·73	8·62	1·46	+7·16
	Dera Ismail Khan ...	0·05	0·47	—0·42	2·28	0·37	+1·91
	Lahore ...	0·05	1·05	—1·00	5·34	0·96	+4·38
	Ludhiana ...	0·11	2·09	—1·98	5·14	1·09	+4·05
	Delhi ...	0·05	1·35	—1·20	3·96	0·66	+3·30
North-Western Provinces ...	Roorkee ...	0·28	2·05	—1·77	4·22	1·18	+3·04
	Agra ...	0·11	0·68	—0·57	1·85	0·11	+1·74
	Lucknow ...	0·58	1·36	—0·78	1·44	0·17	+1·27
	Allahabad ...	0·51	1·04	—0·53	1·31	0·16	+1·15
	Gorakhpur ...	0·44	0·61	—0·17	4·01	0·33	+3·68
Behar ...	Patna ...	0·17	0·51	—0·34	3·47	0·43	+3·04
	Durbhanga ...	0·23	0·60	—0·37	2·67	0·50	+2·17
	Purneah ...	0·15	0·35	—0·20	3·91	0·62	+329
Rajputana ..	Jeypore ...	0	0·55	—0·55	1·11	0·20	+0·91
	Ajmere ...	0	0·44	—0·44	0·96	0·29	+0·67
Central India ..	Jhansi ...	0·37	0·58	—0·21	1·00	0·35	+0 65
	Nowgong ...	0·25	1·11	—0·86	1·24	0·28	+0·96
	Saugor ...	0·10	1·39	—1·29	0·02	0·28	+0·34
	Jubbulpur ...	0·05	1·28	—1·23	0·89	0·31	+0·58

This table exhibits fully the contrast between the rainfall of December and January and that of February, and also the excessive character of the latter.

As might be expected from the circumstances under which the rainfall of the cold weather occurs, the precipitation in the hill districts of Northern India was even more excessive than in the adjacent plains. The following gives data for the hill stations similar to that in the preceding table :—

Stations.	Rainfall from 15th December to 27th January.			Rainfall from 28th January to 28th February.		
	Actual.	Average.	Variation.	Actual.	Average.	Variation.
Murree	2·57	2·92	—0·35	18·58	2·87	+15·71
Simla	1·97	2·78	—0·81	10·38	2·62	+ 7·76
Mussoorie	1·48	?	?	12·26	?	?
Ranikhet	1·28	2·56	—1·28	8·78	1·85	+ 6·93
Quetta	2·10	1·99	+0·11	2·89	1·83	+ 1·06

No such rainfall has occurred in February during the past fifteen or sixteen years, so far as can be ascertained from the records of the Meteorological Office. The most remarkable feature was, that at the hill stations the precipitation during the storms occurred chiefly as rain and not as snow, and hence there has been apparently no excessive accumulation of snow in the hill districts, such as occasionally happen to influence the weather in Northern India. This inference from the weather at the hill stations is confirmed by the few snowfall reports that have been received up to date. Thus the Deputy Commissioner of Kohat states "that there was a good fall of snow on the Sufed Koh and neighbouring mountains on the last week of January, but that heavy rain followed the snowfall and washed the greater part away."

The Political Officer, Khyber, writes as follows respecting the snowfall in the Khyber and Tirah Hills :—"Snow fell on three different occasions in January, and the amount was reported to have been from one to three feet. Heavy rain fell during February and was followed by snow. The depth was reported to be about two feet."

The Assistant Commissioner, Kulu, states "that between 30th January and 2nd February there was an exceptionally heavy fall of snow, and that up to that date the winter had been one of frequent showers of exceptional severity."

No reports have been received up to date from the Assam and Sikkhim Himalayas.

Hence it is almost certain that there is not at present any excessive accumulation of snow in the Himalayan and Afghan Mountain areas, and it is also probable, after the dry cold-weather season of 1886-87 and 1887-88, that the amount of snow at the present time is not above the average. This appears to be confirmed by the excessive temperature which has prevailed during the past fortnight over the whole of Northern India. For example, the mean temperature at Ajmere and Dera Ismail Khan on the 13th and 14th was 13° above the normal temperature of the day.

The following table shows the actual average rainfall and the normal rainfall of the month of the twenty-one districts into which the country is divided so far as it is indicated by the telegraphic reports of a few stations in each district :—

Districts.	No. of Stations.	Normal Average rainfall in February.	Actual average rainfall in Feb. 1889.	Difference from the average in Feb. 1889.
Punjab, West	7	1·17	4·69	+3·52
„ East	4	0·96	3·27	+2·31
North-Western Provinces, Trans-Gangetic ..	7	0·55	1·92	+1·37
„ „ Cis-Gangetic ..	3	0·15	1·22	+1·07
Behar	2	0·34	2·33	+1·99
Northern Bengal	3	0·82	1·26	+0·44
Assam, Cachar	3	1·23	1·84	+0·61
Lower Bengal—Chutia Nagpur	8	1·11	1·12	+0·01
Orissa, North Circars	5	0·46	0·46	0
Central Provinces, South	7	0·28	0·26	—0·02
Berar—Khandesh	2	0·07	0·19	+0·12
Rajputana, Central India, Saugor and Nerbudda ..	9	0·25	0·64	+0·39
Sind—Cutch	3	0·26	0·34	+0·08
Guzerat	3	0·08	0·03	—0·05
Konkan	4	0·02	0	—0·02
Deccan—Hyderabad	5	0	0	0
Malabar	5	0·16	0·16	0
Mysore—Bellary	4	0·11	0·03	—0·08
Carnatic	6	0·22	0	—0·22
Lower Burma	7	0·14	0·02	—0·12
Ceylon	1	2·36	0·38	—1·98

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